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TITLE: ENERGY USE IN OHIO AGRICULTURE

The attached tables on energy use in Ohio agriculture have been prepared as a reference source for farmers, policy makers, farm service personnel and others interested in the needs and performance of the agricultural sector. Energy inputs are recognized as vital components of agricultural production and in recent years, have become a significant cost item for agriculture. The supply, availability and price of various energy sources, however have followed substantially different trends. This is likely to continue. For example, political unrest in the Middle East has affected the availability and price of petroleum products in the past and may do so again. Deregulation of natural gas will change its price relationship to petroleum products and thus have a greater impact on farm activities that use large quantities of natural gas or natural gas products, such as nitrogen fertilizer. Policy makers, farmers and farm service personnel need to be aware of the amount of each type of energy resource used in agriculture and how that use differs by farm activity in order to anticipate and plan for the consequences of these and other potential changes in the energy situation.

We have presented the data on energy use in Ohio agriculture in a flexible format to provide for several levels of interpretation. For example, energy is measured in BTU's, purchased in units such as gallons or cubic feet and paid for with dollars. A specific table is given for each of these measurements. Several major crops with distinctly different energy needs are listed separately. Indirect energy use for fertilizer and pesticide production has been included while

energy for the manufacture of machinery has not. Crop drying off-farm has been listed as a separate item, to be included or excluded as the reader may choose. Since several sources and some personal judgment were used in constructing the following tables, we have outlined the procedure followed in an appendix.

Observations

Total energy cost to Ohio agriculture including the energy component of fertilizer and energy for off-farm crop drying amounted to \$398 million in 1981. This is \$36 per crop acre, 11 percent of gross farm receipts or 15 percent of production costs. Gasoline and diesel fuel together account for one-half of total energy costs. Natural gas at 22 percent and electricity at 18 percent are also major energy sources. Among farm enterprises, corn requires \$203 million or 51 percent of all energy used in Ohio agriculture (\$50 per acre), while soybeans use only 14 percent on slightly fewer acres (\$16 per acre). All crops account for 85 percent, with the remaining 15 percent attributed to livestock. Direct energy use on the farm is valued at \$262 million or 66 percent, indirect use for fertilizer and pesticides is \$131 million or 33 percent, and off-farm drying at \$5 million makes up the remaining one percent.

Some Issues

Some crop enterprises are highly dependent on oil and natural gas based fuels and thus are more vulnerable to energy supply and price changes. Among the crops, corn is a very high energy user and corn production costs are particularly sensitive to energy price movements. Full natural gas deregulation, for example, could double natural gas prices. Thus, deregulation may raise total energy costs to agriculture by as much as 22

percent (assuming no change in cost of other fuels). Corn energy costs alone would rise 32 percent or \$16 per acre, while soybean energy costs would rise only 6 percent or \$1 per acre. Alternatively, changes in the cost of electricity would impact most strongly on livestock production where electricity accounts for 30 percent of energy costs.

Table 1: Ohio Agricultural Energy: Value of Inputs by Source and Use - 1981 (\$1,000)^{1/}

Energy Input	Corn and Corn Silage	Soybeans	Wheat	Hay	Oats	Other Crops	Total Crops	Livestock	Total Direct	Percent	Total On Farm	Percent	Total On & Off Farm	Percent
I. Direct Energy														
Gasoline	39,848	24,570	17,509	18,239	2,948	1,114	104,538	16,434	122,762	46.9	122,762	31.3	122,762	36.8
Diesel Fuel	34,715	21,241	4,516	1,752	1,028	484	63,946	17,976	81,922	31.3	81,922	20.9	81,922	26.4
L.P. Gas	26,471	-	-	-	-	101	26,572	4,930	33,511	12.8	33,511	8.5	34,362	8.8
Natural Gas	87	-	-	-	-	-	87	5	92	<.1	82,951	21.1	86,366	21.7
Electricity	2,181	1,437	721	466	130	64	4,999	17,742	22,741	8.7	66,510	17.7	78,737	17.8
Fuel Oil	-	-	-	-	-	703	703	141	844	.3	1,847	.5	1,847	.5
Coal	-	-	-	-	-	-	-	26	26	<.1	163	<.1	163	<.1
Total	105,502	47,248	22,826	20,457	4,106	2,670	202,617	39,283	261,900	100.0	362,766	100.0	398,130	100.0
Percent	(40.2)	(18.0)	(8.7)	(7.8)	(1.6)	(1.0)	(77.3)	(22.3)	(100.0)					
II. Indirect Energy^{2/}														
Natural Gas	42,230	3,421	11,494	3,637	977	1,090	62,859	-	62,859	63.3	-	-	-	-
Electricity	30,073	5,491	5,006	5,300	731	1,040	48,740	-	48,740	39.8	-	-	-	-
Fuel Oil	400	133	130	90	19	20	1,101	-	1,101	.8	-	-	-	-
Coal	81	22	17	11	2	4	137	-	137	.1	-	-	-	-
Total	83,684	9,367	17,647	7,038	1,729	1,154	130,666	-	130,666	100.0	-	-	-	-
Percent	(71.1)	(7.1)	(13.4)	(5.4)	(1.3)	(1.7)	(100.0)	-	(100.0)					
III. Total Energy														
On-Farm	196,346	56,599	40,373	27,495	5,835	4,877	335,483	39,283	392,766					
Percent	(50.5)	(14.4)	(10.3)	(7.0)	(1.5)	(1.2)	(84.9)	(13.1)	(100.0)					
IV. Off-Farm Energy (Drying)														
Natural Gas	2,729	90	-	948	-	3,355	-	3,355	3,355	62.5	-	-	-	-
Electricity	808	236	146	-	35	1,227	-	1,227	1,227	22.6	-	-	-	-
L.P. Gas	391	-	-	-	-	391	-	391	391	7.9	-	-	-	-
Total	4,328	334	146	983	35	5,373	-	5,373	5,373	100.0	-	-	-	-
Percent	(100.0)	(6.2)	(2.8)	(18.3)	(.6)	(100.0)	-	(100.0)						
V. Total Energy On & Off Farm														
Energy	202,674	56,933	40,519	28,478	5,870	4,877	335,838	39,283	398,130					
Percent	(50.8)	(14.3)	(10.2)	(7.1)	(1.5)	(1.2)	(85.1)	(14.9)	(100.0)					

^{1/} Dollar values determined by multiplying physical quantities in Table 2 by following prices: Gasoline \$1.30/gal., Diesel \$1.10/gal., L.P. Gas \$1.05/gal., Fuel Oil \$1.10/gal., Natural Gas (farm) \$4.66/1000 cu.ft., Electricity (farm) \$6.62/kwh (industry \$4.40/kwh), Coal \$3.54/ton.

^{2/} Includes fertilizer and pesticides only. See Tables 2 and 3 and section IV in Appendix.

Table 2: Ohio Agricultural Energy - Quantity of Inputs by Source and Use - 1981

Energy Input	Corn and Corn Silage	Soybeans	Wheat	Hay	Oats	Other Crops	Total Crops	Livestock	Total	Indirect Energy	Total On-Farm	Off-Farm Drying	Total On & Off Farm
(1000 units)													
Direct Energy													
Gasoline (Gal)	39,848	18,880	13,530	14,030	2,360	837	80,237	16,189	96,427	-	96,427	-	96,427
Diesel Fuel (Gal)	29,172	17,830	3,799	1,472	684	363	53,730	15,186	68,916	-	68,916	-	68,916
L.P. Gas (Gal)	40,500	-	-	-	-	143	40,643	7,825	47,668	-	47,668	1,125	48,793
Nat. Gas (Cu.Ft.)	16,730	-	-	-	-	-	16,730	1,000	17,730	27,428,044	27,444,699	1,148,855	28,593,554
Electricity (Kwh)	32,854	21,700	10,608	7,038	1,871	664	75,517	280,000	355,517	1,861,625	1,386,142	27,333	1,413,475
Fuel Oil (Gal)	-	-	-	-	-	507	507	117	624	916	1,620	-	1,620
Coal (Tons)	-	-	-	-	-	-	-	1,366	1,366	7,380	6,670	-	6,670
Indirect Energy^{1/}													
Nat. Gas (Cu.Ft.)	20,750,300	1,140,536	3,633,273	1,212,614	325,900	365,907	27,020,644	-	27,020,644	-	-	-	-
Electricity (Kwh)	669,770	126,741	131,542	73,481	16,369	23,783	1,041,625	-	1,041,625	-	-	-	-
Fuel Oil (Gal)	540	144	108	73	14	24	916	-	916	-	-	-	-
Coal (Tons)	4,329	1,164	600	686	127	200	7,306	-	7,306	-	-	-	-
Off-Farm Energy (Drying)													
Nat. Gas (Cu.Ft.)	830,125	32,530	-	176,180	-	-	1,110,635	-	1,110,635	-	-	-	-
Electricity (Kwh)	16,000	5,290	3,300	-	763	-	27,333	-	27,333	-	-	-	-
L.P. Gas (Gal)	1,125	-	-	-	-	-	1,125	-	1,125	-	-	-	-

^{1/} Includes fertilizer and pesticides only. The estimated substitution are given below.

Fertilizer (Tons)													
N	307	8	56	14	4	4	393	-	393	-	-	-	-
P ₂ O ₅	137	31	46	26	7	3	270	-	270	-	-	-	-
K ₂ O	206	57	47	46	6	4	366	-	366	-	-	-	-
Pesticides (Tons)													
Insecticides	7,765	5,830	50	15	24	130	13,744	-	13,744	-	-	-	-
Fungicides	2,010	-	-	20	-	612	2,642	-	2,642	-	-	-	-
Herbicides	-	-	-	-	-	334	334	-	334	-	-	-	-

Table 3 Ohio Agricultural Energy, Quantity of Inputs of Source and Use in Billions of BTUs - 1981

Input	Corn and Corn Silage	Soybeans	Wheat	Hay	Oats	Other Crops	Total Crops	Livestock	Total	Percent	Total On-Farm	Percent	Total On & Off-Farm	Percent
Direct Energy														
Gasoline	5,801	2,344	1,678	1,740	281	106	9,950	1,760	11,710	43.3	11,710	19.4	11,710	19.0
Diesel Fuel	4,084	2,499	551	206	121	82	7,523	2,115	9,638	35.6	9,638	16.0	9,638	15.6
L.P. Gas	5,726	-	-	-	-	13	3,739	646	4,385	16.2	4,385	7.3	4,385	7.3
Natural Gas	20	-	-	-	-	-	20	1	21	<.1	20,515	48.9	30,709	49.8
Electricity	115	74	37	24	7	3	258	914	1,172	4.3	4,726	7.8	4,819	7.8
Fuel Oil	-	-	-	-	-	82	82	16	98	.4	224	.4	224	.4
Coal	-	-	-	-	-	-	-	16	16	<.1	104	.2	104	.1
Total	11,744	4,917	2,246	1,970	409	266	21,572	5,468	27,040	100.0	60,302	100.0	81,693	100.0
Percent	(45.4)	(18.2)	(8.3)	(7.3)	(1.5)	(1.1)	(79.8)	(20.2)	(100.0)					
Indirect Energy ^{1/}														
Natural Gas	22,151	1,217	4,092	1,295	548	591	29,494	-	29,494	88.7	-	-	-	-
Electricity	2,285	432	449	251	50	81	3,554	-	3,554	10.7	-	-	-	-
Fuel Oil	76	20	15	10	2	3	126	-	126	.4	-	-	-	-
Coal	52	14	11	7	2	2	88	-	88	.2	-	-	-	-
Total	24,564	1,683	4,567	1,563	600	677	33,262	-	33,262	100.0	-	-	-	-
Percent	(75.9)	(5.1)	(15.7)	(4.7)	(1.2)	(1.4)	(100.0)	-	(100.0)					
Total Energy														
On-Farm	36,508	6,600	6,815	3,533	817	763	54,834	5,468	60,302	1	-	-	-	-
Percent	(60.2)	(10.9)	(11.3)	(5.9)	(1.3)	(1.3)	(90.9)	(9.1)	(100.0)					
Off-Farm Energy (Drying)														
Natural Gas	971	35	-	188	-	-	1,194	-	1,194	85.8	-	-	-	-
Electricity	67	18	11	-	3	-	93	-	93	6.7	-	-	-	-
L.P. Gas	104	-	-	-	-	-	104	-	104	7.5	-	-	-	-
Total	1,156	53	11	188	3	-	1,591	-	1,591	100.0	-	-	-	-
Percent	(81.7)	(3.8)	(0.8)	(13.5)	(0.2)	-	(100.0)	-	(100.0)					
Total Energy On & Off Farm	57,444	6,653	6,824	3,721	820	763	56,225	5,468	61,693					
Percent	(60.2)	(10.8)	(11.1)	(6.0)	(1.3)	(1.2)	(91.1)	(8.9)	(100.0)					

1/ Includes fertilizer and pesticides only. The estimated BTUs are given below.

Fertilizer									
N	20,233	520	5,686	956	278	278	25,951	-	25,951
P ₂ O ₅	2,101	415	619	353	89	39	3,616	-	3,616
K ₂ O	1,114	306	255	248	35	22	1,980	-	1,980
Pesticides									
Herbicide	835	443	6	2	3	16	1,305	-	1,305
Insecticide	279	-	-	-	-	84	367	-	367
Fungicide	-	-	-	-	-	38	38	-	38

Appendix

Procedures and Data Used to Estimate Ohio Agricultural Energy Inputs

1. Energy Input Estimates Per Acre -- Three data sources were used to estimate energy use. They are the 1980 crop budgets for Ohio developed by the USDA as part of the Farm Enterprise Data System (FEDS budgets), and the Energy and U.S. Agriculture 1974 and 1978 Data Bases, including a revised 1974 data base. The 1974 original data base included off-farm crop drying, while the revised 1974 data base did not. Estimates for off-farm drying reflect the differences between these two sources. All data is adjusted to represent 1981 crop acreage and yield. The energy input estimates were determined as follows:

- (1) Gasoline, diesel fuel, L.P. gas, and fertilizer inputs are based on the 1980 FEDS budgets for Ohio.
- (2) Electricity use is based on the 1974-1978 Data Bases and is divided into three parts: overhead, on-farm crop drying, and off-farm crop drying.
- (3) Natural gas use on-farm is allocated entirely to corn grain.
- (4) Chemical inputs are derived from the 1974 original data base.
- (5) Energy inputs for corn and corn silage are shown separately in the table below, however, they are combined in the state summary tables, as are alfalfa and other hay.

Energy Inputs Per Acre

Input	Corn				Other			Other	
	Corn	Silage	Soybeans	Wheat	Alfalfa	Hay	Oats	Crope	
Gasoline (gal.)	7.3	11.5	5.4	8.2	11.5	8.3	8.4	7.2	
Diesel fuel (gal.)	6.7	14.2	5.1	2.3	1.4	0.9	3.2	4.9	
L.P. Gas (gal.)	10.8	-	-	-	-	-	-	1.2	
Natural Gas (cu.ft.)	5.0	-	-	-	-	-	-	-	
Electricity (kwh)	8.4	5.1	6.2	6.6	5.1	5.1	7.3	8.1	
<u>On-Farm - Indirect</u>									
Fertilizer (lbs)									
N	153.4	132.9	4.5	67.7	17.0	23.0	31.4	70.8	
P ₂ O ₅	77.5	80.8	17.7	56.0	63.0	25.8	49.6	49.0	
K ₂ O	103.6	91.8	32.4	57.3	120.0	39.8	47.9	67.5	
Chemicals (lbs.)									
Herbicide	1.8	1.8	1.1	.03	.02	.006	.00	1.17	
Insecticide	.5	.5	-	-	.06	-	-	5.14	
Fungicide	-	-	-	-	-	-	-	2.81	
<u>Off-Farm - Drying</u>									
L.P. Gas (gal.)	.3	-	-	-	-	-	-	-	
Natural Gas (cu.ft.)	282.7	-	9.3	-	383	-	-	-	
Electricity (kwh)	4.8	-	1.5	2.0	-	-	2.9	-	

II Crop Acreage Estimates -- Based on crop reporting data, estimates for the 1981 crop year are:

Corn Grain	3,750,000
Corn Silage	285,000
Soybeans	3,500,000
Wheat	1,650,000
Alfalfa	460,000
Other Hay	920,000
Oats	270,000
Other Crops	119,000
All Crops	10,954,000

III. Direct Energy Use Estimates By Crops -- Acreages under II were multiplied by per acre estimates developed in I and listed in Table 2.

IV Estimate of Energy used to Manufacture Fertilizers and Chemicals -- Three data sources were used to estimate energy needs in the production of fertilizers and chemicals. They are, "Energy and U.S. Agriculture: 1974 Data Base," Energy Policies. Price Impact on the U.S. Food System," USDA/ERS Agricultural Economics Report No. 407, and "The Manufacture and Marketing of Nitrogen Fertilizers in the United States," USDA/ERS Agricultural Economic Report No. 390.

The percentage breakdown of various forms of energy use for production of fertilizers and chemicals is given in Report No. 407 as follows: Fuel oil .4 percent, natural gas 88.5 percent, coal 0.3 percent and electricity 10.8 percent.

Nitrogen fertilizer production consumes 77.6 percent of the total energy used in the production of fertilizers and chemicals, ("Invested Energy," 1974 Data Base) and uses two energy sources, natural gas 96.3 percent and electricity 3.7 percent (Report 390). Since nitrogen fertilizer accounts for the greatest share of energy used, it was estimated first.

The remainder of the energy used in the production of other fertilizer and chemicals was determined by subtracting the energy used in nitrogen production from total "Invested Energy" (Data Base 1974) and allocating it among energy sources to conform with the percentages in Report No. 407. The following percentages for chemicals and other fertilizer were used: fuel oil, 1.7 percent, natural gas, 61.6 percent, coal, 1.2 percent; and electricity, 35.5 percent. Using the BTUs of the different energy forms and chemicals (See VI below) the quantities of energy inputs were determined as follows:

Energy Required For Manufacture of Fertilizers and Chemicals

	Natural Gas (cu.ft.)	Fuel Oil (gal.)	Electricity (kwh)	Coal (pounds)
Fertilizer (1 ton)				
N	59,539.1	-	715.7	-
P ₂ O ₅	7,732.5	1.6	1,394.2	13.4
K ₂ O	3,116.1	.7	361.8	5.4
Chemicals (1,000 pounds)				
Herbicide	66,360.7	14.1	11,965.1	115.0
Insecticide	79,632.8	14.9	14,358.1	138.0
Fungicide	66,360.7	14.1	11,965.1	115.0

V Determination of total BTU's is based on the following values:

Gasoline	124,000 BTU/Gallon
Diesel Fuel	140,000 BTU/Gallon
Fuel Oil	138,500 BTU/Gallon
L.P. Gas	92,000 BTU/Gallon
Natural Gas	1,067.5 BTU/Cu.Ft.
Electricity	3,412 BTU/Kwh
Coal	24,000,000 BTU/Ton
Fertilizer	
N	66,000,000 BTU/Ton
P ₂ O ₅	13,400,000 BTU/Ton
K ₂ O	5,400,000 BTU/Ton
Chemicals	
Herbicide	115,000 BTU/Pound
Insecticide	138,000 BTU/Pound
Fungicide	115,000 BTU/Pound

VII Dollar values of energy inputs were calculated using the following 1981 price information:

Gasoline	\$1.30/gallon
Diesel fuel	\$1.19/gallon
L.P. gas	\$.703/gallon
Natural gas	Farm \$4.666/1,000 cu. ft. Industry 2.999/1,000 cu. ft.
Electricity	Farm 6.62¢/kwh Industry 4.49¢/kwh
Fuel oil	\$1.202/gallon
Coal	\$37.56/ton

Sources Federal Energy Administration. Energy and U.S. Agriculture: IV Data Base, Vol. 1 & 2. Washington, D.C., 1976.

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